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Estimation of Water Requirements in Rice and Groundnut Crops over Telangana

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ABSTRACT: The present research work was carried out to study the water requirements of rice and groundnut crops grown in Telangana districts for baseline (1981-2018) period. Weather data was collected from CRIDA Hyderabad, for computing reference evapotranspiration (ETo), effective rainfall, crop and irrigation water requirements using CROPWAT 8.0 model software. The analysis showed that ETo was at peak in month of May while it was minimum during the month of December. The simulation studies also indicated that there is a substantial increase in ETo values for future line period 2025 & 2030 due to increase in temperature. The crop water requirements for rice crop cultivated during kharif season was estimated to be 727.4mm. The groundnut crop requires 325.5mm water to attain maturity. The maximum irrigation water requirements for rice crop was 1011mm during kharif. It was also estimated that irrigation water requirement for groundnut was about 42.5mm for baseline period. The projected weather for (2025 & 2030) collected from Marksim Weather Generator were used to estimate future water requirements for selected regions and the results showed that water requirements were higher for future period as compare to base period. The studies indicated that efficient water management becomes crucial and critical during normal or deficit rainfall years. Further, it can be concluded that CROPWAT model serves as a best tool for proper irrigation management and scheduling. The outcome of this study helps to guide the policy makers and farming community to plan for a better management of irrigation water to achieve better production.

Keywords: Crop water requirement; Irrigation water requirement; Reference evapotranspiration; Effective rainfall, CROPWAT, ArcGis

INTRODUCTION

Water is a precious component that sustains the life over the world. To guard this precious element from vulnerability we must contemplate effective management for water resource. To utilize this vulnerable resource rigorously one should take into consideration of irrigation agriculture water demand, as a result of irrigation agriculture utilizes about 70% of water extract worldwide. Further, these days upto 95% of accessible water is used for irrigation agriculture in many developing countries. Water for agriculture is turning into increasingly scarce in the light of growing water demands from totally different sectors. Water facility matters in the world which will presently need to grow food for billions of additional people because the world population is projected to peak at 9.3 billion in 2050, a rise of 28%.

The main purpose of associate irrigation system is to maximize crop production to boost economic growth and alleviate the hunger and economic condition within the country. Therefore, water must be distributed with efficiency, for the crops at proper time with a good amount of economical water allocation, that may result in saving water, increasing the plough land space to some more extent, as an alternative in victimization that quantity of saved water for different economic and social purposes like domestic and industrial use so as to optimize water use and crop productivity, one should improve the water resource allocation optimally during a water limiting condition region (arid and semi-arid), improve irrigation scheduling and establish crop water needs, that square measure influenced by the speed of water used with the crops, evapotranspiration(ET) and other losses like soil retention characteristics. Evapotranspiration (FAO, 1998) and yield responses to water (FAO, 1979).

The importance of water demand of crops at the various stages, the current study entitled "Estimation of Water Requirements in Rice and Groundnut crops over Telangana" was carried out using the CROPWAT model which can adequately predict the result of water stress, however needs the standardization of most crop parameters.

MATERIALS AND METHODS

Study area. Telangana is a state in India situated at 18.1121°N, latitude and 79.0193°E longitude on the centre-south stretch of the Indian peninsula on the high Deccan Plateau. Telangana is a semi-arid area and has a predominantly hot and dry climate. Summers start in March, and peak in May with average high temperatures in the 42 °C (108 °F) range. The monsoon arrives in June and lasts until September with about 755 mm (29.7 inches) of precipitation. A dry, mild winter starts in late November and lasts until early February with little humidity and average temperatures in the 22–23 °C (72–73 °F) range.

Meteorological Data. Daily meteorological data was collected for the period 1981-2017 from CRIDA, Hyderabad. Future meteorological data (2025, 2030) was generated using Marksim Weather Generator.

Model Description. In this model, most of the equation parameters are directly measured or can be readily calculated from weather data. The equation can be utilized for the direct calculation of any crop evapotranspiration (ETc). The FAO Penman-Monteith method to estimate the reference evapotranspitration (ETo) is:

$$ETo = \frac{0.408\Delta(Ra - G) + \gamma \frac{900}{T + 273} u2(es - ea)}{\Delta + \gamma(1 + 0.34u2)}$$

Where,
ETo = Reference evapotranspiration (mm per day), Ra = Net radiation at the crop surface (MJ/m² per day), G = Soil heat flux density (MH/m² per day), T = Mean daily air temperature at 2m height (°c), u_2 = Wind speed at 2m height (m/s), e_s = Saturation vapour pressure (kPa), e_a = Actual vapour pressure (kPa), $e_s - e_a$ = Saturation vapour pressure deficit (kPa), γ = Psychometric constant, Δ = Slope vapour pressure curve [kPa °C-1].

Effective rainfall (ER). This model is available with four Effective Rainfall methods, but the USDA Soil Conservation Service method is the default. To calculate the effective rainfall the USDA Soil Conservation Service method was used (Smith, 1991).

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$$Peff = Ptot \times \frac{128 - 0.2 \times Ptot}{128} \quad \text{for } P_{tot} < 250\text{mm}$$

$$Peff = 125 + 0.1 * Ptot \quad \text{for } P_{tot} > 250\text{mm}$$

Where,

Peff = Effective rainfall (mm)
Ptot = Total rainfall (mm)

Estimation of Crop Water Requirement (ETc) . Crops require the water mainly to meet the evapotranspiration demand. The monthly climatic data (temperature, humidity, sunshine, wind) was used to work out the reference evapotranspiration. Reference evapotranspiration was worked out by using CROPWAT model. The monthly rainfall data was converted to effective rainfall by using CROPWAT. The potential crop evapotranspiration (PET) *i.e.*, crop water requirement was estimated using the formula,

ETc = ETo × Kc

Where, ETc = Potential evapotranspiration by the crop (mm/day),
ETo= Reference crop evapotranspiration (mm/day);
K_C = Crop coefficient at a certain growth stage.

Irrigation Water Requirement (IWR). Irrigation requirement is the total quantity of water applied to the land surface in supplement to the water supplied through rainfall and soil profile to meet the water needs of crops for optimum growth. Based on the effective rainfall data in the study area, irrigation water requirements can be calculated from the difference between effective rainfall and the total water requirement.

IR= ETc – ER

RESULT AND DISCUSSION

Reference evapotranspiration . The average daily ETo is maximum in the month of May followed by June and minimum were observed in the month of December. Fig. 1: Represents that ETo shows highest for the Adilabad and Nizamabad districts with 4.74 mm and reached lowest for Khammam with 4.44 mm for Telangana state. Results shows that ETo has low values in rainy season due to high rainfall with high relative humidity compared to dry season. Dry season consists of high temperature and low relative humidity; these conditions are suitable for high ETo. Similar findings were found at Bourima *et al.,* (2015); Adeniran *et al*., (2010).

However it is noted that ETo has increased for the future period. Due to the increasing in temperature the ETo was increased for the particular region and period. While maximum ETo for Telangana state showed 4.77 mm and 4.8 mm for Adilabad district and minimum ETo is observed as 4.47 mm and 4.49 mm for Rangareddy district for 2025 & 2030 respectively.

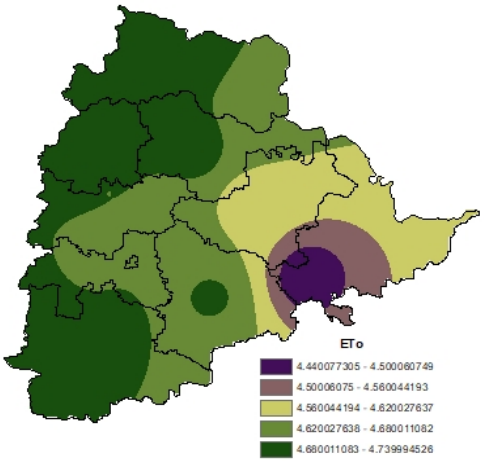

Fig. 1. Map of ETo over Telangana for period 1981-2018.

Effective rainfall. Fig. 2 shows maximum effective rainfall with 790.7 mm at Nizamabad district for 2025 and 742.1 mm for Khammam district. While minimum effective rainfall occurred 619.3mm and 623.2 mm at Rangareddy district respectively. Results revealed that effective rainfall showed a decreasing for the future period as compared to the base period, due to occurrence of more rainfall, percolation process thus to reduce the effective rainfall for a particular region and period.

The highest effective rainfall would be 807.6mm at Khammam district and lowest effective rainfall is 612.7 mm at Mahabubnagar district for base line period and maximum effective rainfall with 790.7 mm at Nizamabad district for 2025 and 742.1 mm for Khammam district. While minimum effective rainfall occurred 619.3mm and 623.2 mm at Rangareddy district respectively.

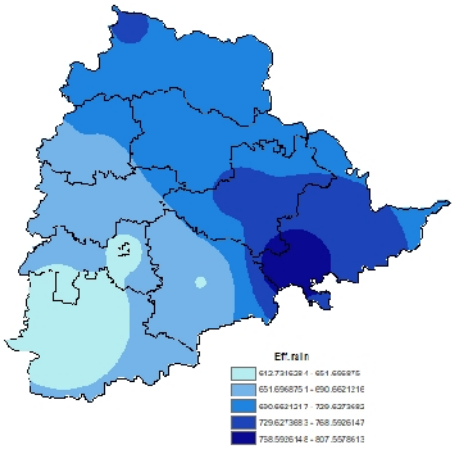

Fig. 2. Map of Effective rainfall over Telangana for period 1981-2018**.**

Crop water requirement - Rice is a major crop in requirement of water compared to all other crops. The highest crop water requirement was found at Mahabubnagar district (727.4 mm) and lowest ETc was found at Khammam with 678.8 mm over Telangana (Fig. 3).

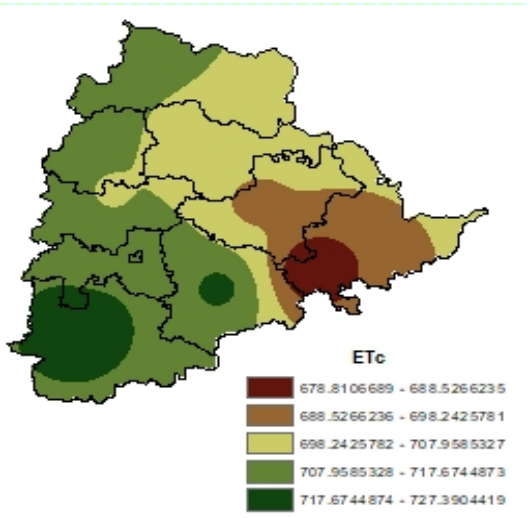

Fig. 3. Map of ETc for rice over TS for baseline period.

The water requirement of rice crop would significantly increase in the districts of Nalgonda with 707.9mm for 2025 and 756.3mm at Mahabubnagar for 2030 periods. While minimum observed at 665.7mm & 665.8mm over Warangal respectively. Groundnut requires more maximum ETc (Fig. 4) in Mahabubnagar district with 325.5 mm and minimum observed at 298.9 mm over Khammam. Groundnut crop would significantly increase at the district of Mahabubnagar with 314.1mm for 2025 and with 324.8mm for 2030 period. While minimum observed at 289.4mm and 288.1mm over Warangal district for 2025 and 2030 respectively.

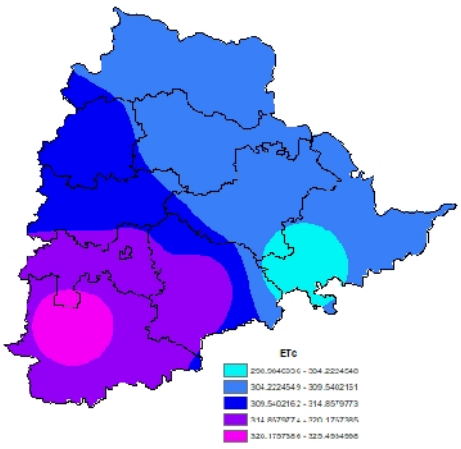

Fig. 4. Map of ETc for groundnut over TS for baseline period.

Irrigation water requirement - The simulated results through cropwat model shows total irrigation water requirement requires the highest irrigation water requirement occurred at Mahabubnagar district with 1011mm and lowest irrigation water requirement occurred at Adilabad with 278.9mm for base line period (Fig. 5) illustrate the irrigation requirement of rice at the Telangana during crop season. While groundnut crop requires the highest irrigation water requirement occurred at Mahabubnagar district with 42.5mm and lowest irrigation water requirement occurred at Khammam and Warangal with 1.6mm for base line period.

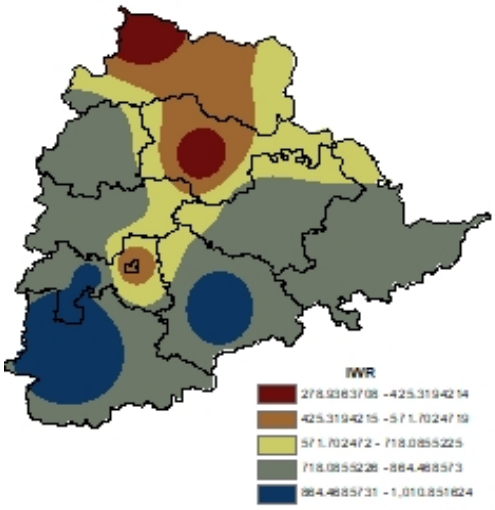

Fig. 5. IWR for rice over TS for baseline period.

Total maximum irrigation water requirement for groundnut was estimated with 15.3mm at Nalgonda district for 2025 and 8.9mm at Hyderabad for 2030 respectively. While minimum would be 1.6mm at Warangal district for 2025 and 1.6mm for Medak district for 2030. The maximum irrigation requirement was higher during the maturity stage. Hence irrigation water requirement increased considerably due to less rainfall in future.

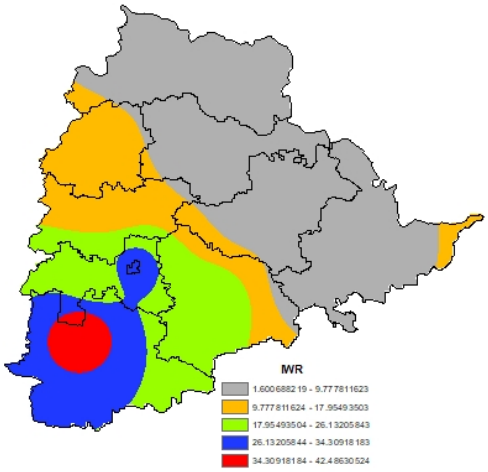

Fig. 6. IWR for groundnut over TS for baseline period.

The highest irrigation water requirement for rice would be occurred at Mahabubnagar district with 1011mm and lowest irrigation water requirement occurred at Adilabad with 278.9mm for base line period. Total maximum irrigation water requirement was estimated with 946.7mm and 942.2mm at Nalgonda district for 2025 & 2030 respectively. While minimum would be occurred 308.6mm and 305.6 mm for Nizamabad district for 2025 & 2030 respectively.

Table 1: ETc & IWR of rice and groundnut for future period.

Districts	Base-Line Period				2025				2030			
	Rice		Groundnut		Rice		Groundnut		Rice		Groundnut	
	ETc	IWR	ETc	IWR	ETc	IWR	ETc	IWR	ETc	IWR	ETc	IWR
Adilabad	278.9	1143.2	306.9	2.3	688.5	835.6	291.7	1.8	694.2	838.3	294.4	1.9
Hyderabad	441.6	1043.4	317	31.0	680.7	905.2	300.6	10	682	901.7	300.2	8.9
Karimnagar	292.6	755.7	305.5	2.8	704.7	830.2	311.3	3.2	705.9	827.8	311.6	3.1
Khammam	761.1	421.2	298.9	1.6	702.4	828.4	310.6	3.1	703.7	826.2	310.9	2.9
Mahbubnagar	1011	565.4	325.5	42.5	701.1	871.2	314.1	4.5	756.3	922.5	324.8	8.2
Medak	855.1	372.5	310.3	10.0	673.4	810.9	293.9	1.7	672.6	806.7	294	1.6
Nalgonda	973.1	1066.8	319.3	24.4	707.9	946.7	312.5	15.3	708.2	942.2	314.4	1.87
Nizamabad	844.9	598.3	309.9	10.1	679.9	308.6	293.2	1.7	678.5	305.6	292.3	1.7
Rangareddy	900.2	1075.9	316.2	19.5	670.6	885.1	296.8	3.6	671.8	881.6	297.4	3.4
Warangal	807	737.1	304.6	1.6	665.7	809.6	289.4	1.6	665.8	809.8	288.1	1.7

CONCLUSION

From the study it is concluded that results on ETc and IWR provided practical assessment for irrigation scheduling of rice and groundnut crops in study region. These results can be used for a most efficient water use and to optimize production of those crops. It showed the significance of requirement of scientific planning for irrigation. Irrigation water requirement will vary based on the availability of rainfall, so prediction of irrigation requirement is difficult, hence it was concluded that the water requirement will increase in future. Therefore, it is further suggested that water saving practices or techniques for water conservation should be adopted for irrigation on crops.

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